

Biographical Summary

Tianfu Xu is a Career Staff Scientist at the Lawrence Berkeley National Laboratory (LBNL), which he joined in 1996 initially as post-doctoral fellow. He received a bachelor's degree in 1984 from Jilin University of China, an M.S. degree in 1993 from Delft University of Technology of The Netherlands, and a Ph.D. in 1996 from University of La Coruña, Spain. For the last 16 years, Tianfu has been working on developing new approaches to modeling multiphase non-isothermal fluid flow and reactive transport in unsaturated and saturated porous media and fractured rock systems. He is the chief developer of LBNL's multi-phase non-isothermal reactive flow and chemical transport simulator TOUGHREACT. The program is among the most frequently requested codes in the library of the Department of Energy's Software Center, and is widely used nationally and internationally for CO₂ geological sequestration, geothermal energy development, nuclear waste disposal, environmental remediation, and increasingly for petroleum applications. Tianfu has authored and co-authored about 40 peer-reviewed journal papers. His papers have been cited by other researchers more than 360 times (SCI citation).

Research Interests

- Developing new approaches for modeling multiphase non-isothermal fluid flow and geochemical transport in unsaturated and saturated porous media and fractured rock systems.
- Developing novel conceptual models integrating geologic, thermal, geochemical, microbiological and hydrologic data.
- Incorporating conceptual models into numerical modeling codes for the evaluation of subsurface coupled processes.
- ***CO₂ geological sequestration:*** Fate and transport of injected CO₂ in storage reservoirs, mineral trapping, caprock and cement alterations due to CO₂ intrusion, and the impact of CO₂ leakage on groundwater quality.
- ***Natural groundwater quality and environmental remediation:*** Acidic mine drainage remediation, organic matter decomposition, and effective environmental remediation of groundwater contamination.
- ***Geothermal energy development:*** Formation scaling due to water injection, optimization of injection water chemistry, chemical stimulation for enhanced geothermal system (EGS), use of CO₂ as working fluid for EGS (CO₂-EGS), controlling and mineral dissolution and precipitation in the reservoir.

- ***Nuclear waste geological disposal:*** Radionuclide reactive transport, coupled thermo-hydro-chemical (THC) processes, steel canister corrosion and H₂ gas generation.
- ***Reactive transport applications to petroleum processes:*** Porosity evolution of carbonate diagenesis, evaluation of deep injection of H₂S separated from natural gas reservoirs, and optimization of injection water chemistry to avoid formation damage due to waterflooding.

Education and Training

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| Post-doc | 12/1996-11/1998, Earth Sciences Division, Lawrence Berkeley National Laboratory, University of California. |
| Ph.D. | 03/1993-12/1996, Department of Civil Engineering, University of La Coruña, Spain. |
| M.S. | 10/1991-03/1993, Master of Science in Hydrological Engineering, International Institute for Hydraulic and Environmental Engineering, Delft University, The Netherlands. |
| M.S. | 10/1984-8/1987, Master of Engineering in Hydrogeology, University of Jilin, China. |
| B.S. | 9/1980-7/1984, Bachelor Degree in Hydrogeology, University of Jilin, China. |

Professional Positions

Career Staff Scientist: 2006-present, Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, California, USA.

Career Scientist: 2001-2006, Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, California, USA.

Scientist: 1998-2001, Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, California, USA.

Post-Doctoral Research Fellow: 1996-1998, Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, California, USA.

Research Assistant: 1993-1996, Department of Civil Engineering, University of La Coruña, Spain; Development and application of computational simulation techniques for non-isothermal multi-component reactive solute transport through variably saturated porous media.

Research Assistant: 1991-1993, International Institute for Hydraulic and Environmental Engineering, Delft, The Netherlands; A study on land subsidence due to regional groundwater withdrawal.

Hydrogeologist: 1987-10/1991, Worked in the Department of Hydrology and Engineering Geology under the Ministry of Geology and Mineral Resources, Beijing, China.

Publications (Citation on August 18, 2009, total 360)

1. **Xu**, T., J. Samper, C. Ayora, M. Manzano, and E. Custodio, Modeling of non-isothermal multi-component reactive transport in field-scale porous media flow system, *Journal of Hydrology*, v. 214, p. 144-164, 1999. (55 SCI citations)
2. **Xu**, T., K. Pruess, and G. Brimhall. An improved equilibrium-kinetics speciation algorithm for redox reactions in variably saturated flow systems, *Computers & Geosciences*, v. 25(6), p. 655 -666, 1999. (9 SCI citations)
3. **Xu**, T., K. Pruess, and G. Brimhall, Oxidative weathering chemical migration through an unsaturated-saturated medium, Contribution to Chapter 5 of “*Vadose Zone Science and Technology Solutions*” book, Edited by Westinghouse Savannah River Company for U. S. Department of Energy, 2000.
4. **Xu**, T., S. P. White, K. Pruess, and G. H. Brimhall, Modeling of pyrite oxidation in saturated and unsaturated subsurface flow systems, *Transport in porous media*, v. 39, p. 25-56, 2000. (17 SCI citations)
5. **Xu**, T., and Pruess, K., On fluid flow and mineral alteration in fractured caprock of magmatic hydrothermal systems, *Journal of geophysical Research*, v. 106(B2), p. 2121-2138, 2001. (12 SCI citations)
6. **Xu**, T., and K. Pruess, Modeling multiphase non-isothermal fluid flow and reactive geochemical transport in variably saturated fractured rocks: 1. Methodology, *American Journal of Science*, v. 301, p. 16-33, 2001. (50 SCI citations)
7. **Xu**, T., E. Sonnenthal, N. Spycher, K. Pruess, G. Brimhall, and J. Apps, Modeling multiphase non-isothermal fluid flow and reactive geochemical transport in variably saturated fractured rocks: 2. Applications to supergene copper enrichment and hydrothermal flows, *American Journal of Science*, v. 301, p. 34-59, 2001. (14 SCI citations)
8. **Xu**, T., E. Sonnenthal, and G. Bodvarsson, A reaction-transport model for calcite precipitation and evaluation of infiltration-percolation fluxes in unsaturated fractured rock, *Journal of Contaminant Hydrology*, v. 64, p. 113 - 127, 2003. (9 SCI citations)
9. **Xu**, T, J. A. Apps, and K. Pruess, Reactive geochemical transport simulation to study mineral trapping for CO₂ disposal in deep arenaceous formations, *Journal of Geophysical Research*, v. 108 (B2), 2071, doi:10.1029/2002JB001979, 2003. (28 SCI citations)
10. Pruess, K., **Xu**, T., Apps, J., and García, J., Numerical modeling of aquifer disposal of CO₂, Paper SPE-83695, *SPE Journal*, p. 49-60, 2003. (19 SCI citations)

11. Kiryukhin, A., T. **Xu**, K. Pruess, J. Apps, and I. Slovtsov, Thermal-hydrodynamic-chemical (THC) modeling based on geothermal field data, *Geothermics*, v. 33(3), p. 349-381, 2004. (4 SCI citations)
12. Pruess, K., J. García, T. Kavscek, C. Oldenburg, J. Rutqvist, C. Steefel, and T. **Xu**, Code intercomparison builds confidence in numerical simulation models for geologic disposal of CO₂, *Energy*, v. 29, p. 1431-1444, 2004. (23 SCI citations)
13. Todaka, N., C. Akasaka, T. **Xu**, and K. Pruess, Reactive geothermal transport simulations to study the formation mechanism of an impermeable barrier between acidic and neutral fluid zones in the Onikobe Geothermal Field, Japan, *Journal of Geophysical Research*, v. 109, B05209, doi:10.1029/2003JB002792, 2004. (3 SCI citations)
14. Pruess, K., and T. **Xu**, Numerical Simulation of Reactive Flow in Hot Aquifers by Christoph Clauser (Ed.), Springer-Verlag, Berlin, Heidelberg, New York, *Geothermics*, 33, 213-215, 2004.
15. **Xu**, T., Y. Ontoy, P. Molling, N. Spycher, M. Parini, and K. Pruess, Reactive transport modeling of injection well scaling and acidizing at Tiwi Field, Philippines, *Geothermics*, v. 33(4), p. 477-491, 2004. (11 SCI citations)
16. **Xu**, T, J. A. Apps, and K. Pruess, Numerical simulation of CO₂ disposal by mineral trapping in deep aquifers, *Applied Geochemistry*, 19, 917-936, 2004. (50 SCI citations)
17. **Xu**, T, J. A. Apps, and K. Pruess, Mineral alteration due to injection of CO₂, H₂S and SO₂ in deep arkosic formations, in *Water Rock Interaction (WRI-11)* edited by Richard B. Wanty & Robert R. Seal, p. 601-605, A.A. Balkema, London, 2004. (A peer-reviewed book chapter)
18. **Kim**, J., F.W. Schwartz, T. **Xu**, and J. Shi, Coupled processes of fluid flow, solute transport and geochemical reactions in reactive barriers, *Vadose zone Journal*, 2004(3), p. 867-874, 2004. (1 SCI citations)
19. **Xu**, T, J. A. Apps, and K. Pruess, Mineral sequestration of carbon dioxide in a sandstone-shale system, *Chemical Geology*, v. 217(3-4), p. 295-318, 2005. DOI information: 10.1016/j.chemgeo.2004.12.015, 2005. (31 SCI citations)
20. **Xu**, T., CO₂ geological sequestration, *China Encyclopedic Knowledge* (a China popular science magazine), 307(2), 34-35, 2005.
21. Sonnenthal, E., T. **Xu**, and G. Bodvarsson, Reply to “Commentary: Assessment of past infiltration fluxes through Yucca Mountain on the basis of the secondary mineral record—is it a viable methodology?”, by Y.V. Dublyansky and S.Z. Smirnov, *Journal of Contaminant Hydrology*, v. 77(3), p. 225-231, 2005.
22. **Xu**, T., E.L. Sonnenthal, N. Spycher, and K. Pruess, TOUGHREACT - A simulation program for non-isothermal multiphase reactive geochemical transport in variably saturated geologic media: Applications to geothermal injectivity and CO₂ geological sequestration, *Computer & Geoscience*, v. 32/2 p. 145-165, 2006. (26 SCI citations)
23. Randolph, A., W. Zhou, T. **Xu**, K. Pruess, B. Stromberg, Experimental calibration of a reactive-transport model of buffer cementation, *Chinese Journal of Rock Mechanics and Engineering*, v.25, p., 2006.
24. **Xu**, T., Geochemical processes in CO₂ Geological Sequestration, A Chapter of Book “Carbon Capture & Sequestration” (Editor: Elizabeth J. Wilson and David Gerard), Blackwell Publishing, 2007.

25. **Xu**, T., J. A. Apps, K. Pruess, and H. Yamamoto, Numerical modeling of injection and mineral trapping of CO₂ with H₂S and SO₂ in a sandstone formation, *Chemical Geology*, v. 242/3-4, p. 319-346, 2007. (9 SCI citations)
26. Audigane, P., I. Gaus, I. Czernichowski-Lauriol, K. Pruess and T. **Xu**. Two-dimensional reactive transport modeling of CO₂ injection in a saline aquifer at the Sleipner Site, *American Journal of Science*, v. 307, p. 974-1008, 2007. (2 SCI citations)
27. Gherardi, F., T. **Xu**, and K. Pruess, Numerical modeling of self-limiting and self-enhancing caprock alteration induced by CO₂ storage in a depleted gas reservoir, *Chemical Geology*, v. 244, p. 103-129, 2007. (4 SCI citations)
28. Lu, G., T. **Xu**, Solubility enhanced immobility of neptunium in the unsaturated zone at Yucca Mountain, Nevada, Submitted to Nuclear Technology, In press, 2008.
29. Zhang, G., N. Spycher, E. Sonnenthal, C. Steefel, and T. **Xu**, Implementation of a Pitzer Activity Model into TOUGHREACT for modeling concentrated solutions, *Nuclear Technology*, v. 164, p. 180-195, 2008.
30. Birkle, P., K. Pruess, T. **Xu**, R.A. Hernandez-Figueroa and M. Diaz-Lopez, Using laboratory flow experiments and reactive chemical transport modeling for designing waterflooding of the Agua Fria Reservoir, Poza Rica-Altamira Field, Mexico, paper SPE 103869-PP, *SPE Reservoir Evaluation and Engineering*, p. 1029-1045, 2008.
31. Finsterle, S., C. Doughty, M.B. Kowalsky, G.J. Moridis, L. Pan, T. **Xu**, Y. Zhang, and K. Pruess, Advanced vadose zone simulation using TOUGH, *Vadose Zone Journal*, v. 2008-7, p. 601-609, 2008.
32. Maggi, F., C. Gu, W. J. Riley, G.M. Hornberger, R.T. Venterea, T. **Xu**, N. Spycher, C.I. Steefel, and N.L. Miller, Mechanistic modeling of biogeochemical nitrogen cycling: model development and application in an agricultural system, *J. Geophys. Res. (Biogeosciences)*, *J. Geophys. Res.*, 113, doi:10.1029/2007JG000578, 2008.
33. **Xu**, T., R. Senger, and S. Finsterle, Corrosion-induced gas generation in a nuclear waste repository: Reactive geochemistry and multiphase flow effects, *Applied Geochemistry*, v.23, p. 3423-3433, 2008.
34. **Xu**, T., Incorporation of aqueous reaction kinetics and biodegradation into TOUGHREACT: Application of a multi-region model to hydrobiogeochemical transport of denitrification and sulfate reduction, *Vadose Zone Journal*, February issue, p. 305-315, 2008. doi: 10.2136/vzj2006.0130, 2007.
35. Gu, C., F. Maggi, W. J. Riley, G. M. Hornberger, T. Xu, C. M. Oldenburg, N. Spycher, N. L. Miller, R. T. Venterea, and C. I. Steefel, Aqueous and Gaseous Nitrogen Losses Induced by Fertilizer Application, *J. Geophys. Res.*, doi:10.1029/2008JG000788, 2008.
36. Zhang, W., Li, Y., **Xu**, T., Cheng, H., Zheng, Y., Xiong, P., Long-term variations of CO₂ trapped in different mechanisms in deep saline formations: A case study of the Songliao Basin, China, *Greenhouse Gas Control Technologies*, v3(2), p. 161-180, 2009.
37. **Xu**, T., Rose, P., Fayer, S., Pruess, K., On modeling of chemical stimulation of an enhanced geothermal system using a high pH solution with chelating agent, Submitted to *Geofluid*, v. 9, p. 167-177, 2009.
38. Samper, J., T. **Xu**, C. Yang, A sequential partly iterative approach for multicomponent reactive transport with CORE2D, *Computational Geosciences*, v. 13, p. 301-316, 2009. DOI 10. 1007/s10596-008-9119-5.

39. Ito, T., **Xu**, T., Sakurai, M., Sekine, K., A concept of in-situ reaction method to remedy leakage from geological CO₂ storage reservoirs, Greenhouse Gas Control Technologies, Submitted, 2009.
40. **Xu**, T., Zhang, We., Pruess, K., Reaction-driven density increase and convection mixing for Long-Term CO₂ Storage in a Saline Sandstone Formation, Transport in Porous Media (special issues on CO₂ geological sequestration), Submitted, In revising process, 2009.